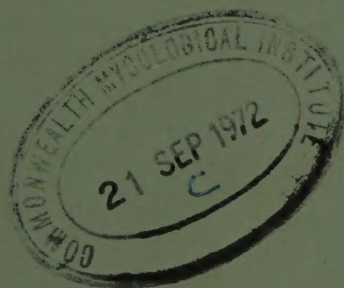


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E. Butler

Castellani & Wilkinson

Trichomycosis





1. *Micrococcus Nigrescens*, Castellani (Glucose Agar Culture). 2. *Micrococcus Castellani*, Chalmers and O'Farrell.
 3. *Trichomycosis Flava*. 4. *Trichomycosis nigra*. 5. *Trichomycosis rubra*. 6 and 7. *Nocardia Tenuis* from hanging drop culture.

TO ILLUSTRATE THE ARTICLE ON TRICHOMYCOSIS BY DR. A. CASTELLANI AND DR. F. A. G. WILKINSON.

OBSERVATIONS ON TRICHOMYCOSIS AXILLARIS FLAVA, RUBRA AND NIGRA.

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DURING the summer months of 1920 and 1921 we have carried out an investigation on the frequency of trichomycosis axillaris in patients admitted to the Tropical Section of the Orpington Hospital. We have found that the incidence of the infection in summer is extremely high, more than 80 per cent. of the patients admitted being affected. In hospital only one variety of trichomycosis was noted—the yellow variety. In private patients, in addition to the yellow variety, we have found two cases of the red and one of the black variety: the observation was made during the spell of very hot weather at the end of July, 1921, and the three patients had just arrived from Ceylon, all by the same boat.

Most of the patients seem to have contracted the affection in tropical and subtropical countries, but it was found also in individuals who had never been out of England or France. To show the frequency of the affection we found that out of 57 patients admitted to two of our wards at Orpington, 51 showed the condition.

GENERAL REMARKS.

Some remarks on trichomycosis axillaris principally based on the observations and researches of one of us in the tropics and various

European countries may not be out of place, as there still appears to be a great deal of confusion concerning the affection, especially as regards its ætiology.

SYNONYMS. HISTORICAL AND GEOGRAPHICAL.

Trichomycosis axillaris, which is also known as lepothrix (*pro parte*), trichomycosis palmellina (*pro parte*), trichonocardiasis axillaris, trichomycosis nodosa, trichomycosis chromatica, chromotrichomycosis, etc., has been known for many years, but only recently its various clinical types have been differentiated by one of us (C.) and the ætiology of each elucidated.

Paxton, in 1869, described a nodular affection of the hair of the axillary and genital regions, which was later named lepothrix by Wilson. Paxton's work was confirmed by Patteson and Pick, who called the condition trichomycosis palmellina. Payne, Eisner, Sonnonberg, Babes and Barthelemy carried out investigations on the ætiology of the condition and described various bacteria, including *Bacillus prodigiosus*, as causative agents. In 1911, Castellani, working in Ceylon, differentiated three varieties of the affection—the yellow variety, due to a fungus which he called *Nocardia tenuis* (*Discomyces*, *Streptothrix*, *Cohnistreptothrix tenuis*); the black variety due to the same fungus plus a black pigment-producing coccus, which he called *Micrococcus nigrescens*; and the red variety, due to the same fungus plus a red pigment-producing coccus, to which later Chalmers and O'Farrell gave the name *Micrococcus castellanii*. The two authors called the conditions trichonocardiasis. Recently Macfie has thoroughly investigated the condition in West Africa and has described a sub-variety of it, which he has called trichomycosis fusca.

ÆTIOLOGY AND PATHOLOGY.

As already stated, the most widely different organisms have been described as causative agents by various observers. In 1911, one of us, studying the condition in the tropics, separated three principal varieties of the affection—the yellow, the black and the red—and carried out some researches with the object of elucidating their ætiology. His researches showed that in the yellow variety a minute fungus was constantly present in enormous numbers (*Nocardia tenuis*,

Castellani, 1911; syns.: *Streptothrix*, *Discomyces*, *Cohnistreptothrix tenuis*, Castellani). In the black variety he found the same fungus plus a black pigment-producing coccus, *Micrococcus nigrescens*, Castellani, 1911, living in symbiosis with it; in the red variety he observed the same fungus plus a red pigment-producing coccus living in symbiosis with it, which later was called *Micrococcus* (*Rhodococcus*) *castellanii* by Chalmers and O'Farrell, who made a very thorough investigation of the affection in the Sudan in 1913.

The microscopical examination of the affected hair with low power shows that the shaft is covered at several places by roundish formations, partially or totally encircling it. Under a high power, using a cleared specimen, these formations will be seen to consist in the yellow variety of enormous numbers of the bacillary-like mycelial hyphæ of *Nocardia tenuis*, embedded in an amorphous cementing substance. In the red and black varieties, in addition to the masses of bacillary-like bodies which are the mycelial segments of *Nocardia tenuis*, large groups of cocci-like bodies are observed (*Micrococcus nigrescens* in the black variety and *Micrococcus castellanii* in the red variety).

Nocardia tenuis, Castellani, 1912. (Syns.: *Discomyces*, *Streptothrix*, *Cohnistreptothrix tenuis*, Castellani, 1912.)

The microscopical examination of the nodules in cleared specimens reveals the presence of enormous numbers of rod-like bodies—the bacilliform hyphæ of a nocardia—which are Gram-positive, but not acid-fast. If the nodules are kept in alcohol or formalin for several months the fungus apparently loses partially or totally its property of being stainable by Gram's method. The bacillary bodies vary in length from 2 to 8 μ and more; the average breadth is approximately 0.14 to 0.3 μ ; they may be straight or slightly bent, very seldom if ever branching; they are fairly closely packed together, and are embedded in a cementing substance, apparently secreted by the fungus. This ground substance is fixed to the cortex of the hair, and a portion of it lies under the cuticle and some of the superficial layers of the cortex. In regard to cultivation, Chalmers and O'Farrell observed some slight growth in hanging drops of equal parts of human serum and normal saline. The fungus grew, showing branching forms and coccal forms (Coloured Plate: 6 and 7). The branching

was monopodial and the hyphæ were non-septate. Macfie, in one case, succeeded in cultivating the fungus on ascitic sugar agar, the colonies being very small and translucent.

Micrococcus (Nigrococcus) nigrescens, Castellani, 1911.

This is a Gram-positive, rather large, non-motile coccus, which in certain media may take the appearance of a cocco-bacillus. It produces a black pigment. Sugar media are more suitable for the growth of the organism than the ordinary agar.

Sabouraud maltose agar.—Colonies appear twenty-four to forty-eight hours after inoculation. They are roundish, at first white, but after a couple of days the centre of each colony turns black, and the pigmentation slowly spreads excentrically. After a time the colonies may coalesce into a jet-black mass.

Glucose agar.—Growth similar to Sabouraud, but slightly less abundant. The black pigmentation develops from the centre of the colonies and slowly spreads towards the periphery (Coloured Plate: 1).

Levulose agar.—Identical to glucose.

Saccharine agar.—The pigmentation is less pronounced, and does not spread to the whole of the growth.

Raffinose agar.—Same as saccharine.

Lactose agar.—Scanty pigmentation.

Alkaline maltose agar.—Black pigmentation well marked, though in many cases it does not extend to the whole of the growth.

Acid maltose agar.—Growth less abundant than on acid maltose. Black pigmentation well marked.

Mannite agar.—As alkaline maltose.

Inulin.—As alkaline maltose, but pigmentation less pronounced.

Saccharose.—As inulin agar.

Glycerine agar.—Abundant growth, the whole of which after a time becomes a jet-black colour.

Galactose.—As inulin.

Adonite.—As acid maltose.

Ordinary agar.—Growth much less abundant than on most sugar agars, and black pigmentation less marked.

Serum.—Growth fairly abundant, but there is only a trace of pigmentation. The medium is not liquefied.

Gelatine.—No liquefaction. The growth on the surface shows after

a time some dark pigmentation, but the growth along the stab is white.

Milk.—No change.

Broth.—General turbidity. A thin pellicle is often present. The microscopical examination shows cocci arranged in pairs or irregularly. They do not appear to be capsulated.

Peptone water.—Some growth at the bottom, while the rest of the tube is clear.

Sugar broths.—No formation of acid or gas.

Indol.—Most strains produce a trace of indol.

Micrococcus (Rhodococcus) castellanii, Chalmers and O'Farrell, 1913.

This coccus, isolated in 1910 by Castellani from the red variety in Ceylon, and later further investigated in the Sudan and named by Chalmers and O'Farrell, is more difficult to isolate and to grow than the coccus observed in the black type of the affection. It is interesting to note that as a rule it grows better and shows more pigment on ordinary agar than on sugar media. It is a round or oval coccus, measuring from about 0.3 to 0.7 μ in diam. It is separated medianly by a clear central line into two half-moon-shaped segments, thus producing a diplococcal appearance. It is colourless and non-motile, but excretes an amorphous non-granular lemon chrome-coloured pigment. In old cultures another pigment of dark brownish-red colour appears (according to Ridgway's standards this colour is madder-brown), but its relationship to the earlier yellow pigment can easily be proved, as demonstrated by Chalmers and O'Farrell, by removing some of it and suspending in a sufficiency of distilled water, when the fluid at once resembles a similar suspension of the yellow pigment. When, however, this is done in a very small quantity of water, a faint reddish tinge can be observed. The best medium for showing the striking yellow pigment is the potato, when in twenty-four hours the growth assumes that colour. The red pigment shows best in the ordinary agar slope, which, when old, exhibits the dark red pigment in the centre and the yellow pigment at the sides (Coloured Plate: 2). The organism is easily stained by all the ordinary staining reagents, and is Gram-positive. However, even in preparations showing most of the cocci well coloured by Gram's methods a few cocci may be seen decolourised, and occasionally one may see cocci with one demilunar

segment well stained while the other is completely decolourised. The organism does not appear to have a capsule.

The coccus grows aërobically and also anaërobically. The optimum temperature appears to be 37° C.; it also grows at 20° C. on agar slopes, but not as abundantly as at 37° C., and the pigmentation is much less marked. Its rate of growth depends somewhat upon the medium; it grows quickest on potato, and next best on ordinary or glycerine agar. On solid media it gives rise to a yellow growth at first, but on most media, if kept long enough, some red colouration will subsequently be found. The best medium for the red colouration, as already stated, appears to be the ordinary agar slope. With regard to the other agar media, it grows well on glucose and maltose agar. Like *Micrococcus nigrescens* it produces neither acid nor gas in glucose, levulose, galactose, arabinose, lactose, saccharose, raffinose, dextrin, inulin, amygdalin, erythrite, adonite, dulcitol, isodulcitol, mannitol, sorbitol or inositol. It grows slowly on blood-serum, which it does not liquefy, and well in broth and peptone water, in which it forms a general turbidity. Gelatine is not liquefied. It does not produce indol.

In agar stabs the growth is confined to the line of puncture and to the formation of a small yellow knob on the surface.

Classification of Micrococcus castellanii.—Chalmers and O'Farrell have thoroughly investigated this point: "The organism belongs to the family *Coccaceæ* (Zopf, emended Migula), and must be grouped with the genus *Micrococcus* (Hallier, 1866, emended Cohn, 1872). In this genus it certainly belongs to those forms which grow well on agar media and are Gram-positive, and in this division it belongs to the sub-division which produces colours.

"The cocci of this sub-division which possess red coloration are only three in number—*Micrococcus roseus* (Baum, 1885), *Micrococcus ruber* (Trommsdorff, 1904), and *Micrococcus rubidus* (Hefferan). Under the term *M. roseus* (Baum, emended Lehmann and Neumann) are gathered a large number of rose-coloured diplococci which are not known to be parasitic, and which produce growths on potato which are limited to the streaks. These growths are faint rose colour with an oily lustre, and are often surrounded by a whitish glistening zone, thus giving rise to a very different appearance from that produced by *M. castellanii*. *Micrococcus ruber* (Trommsdorff, 1904), or, as it is sometimes named,

M. chromidrogenus ruber, which was isolated from a case of chromidrosis, is characterised by the fact that it does not grow on potato; its colouring matter is not soluble in water, and when treated by sulphuric acid the red colour turns blue-green, while *M. castellanii* does grow on potato and its colouring matter is unaffected by 25 per cent sulphuric acid; it appears to be closely related to *M. roseus* var. *carneus*, and to be non-parasitic."

PATHOLOGY.

From our own observations and those of Chalmers and O'Farrell it would appear that when the nocardial fungus first attacks the hair,

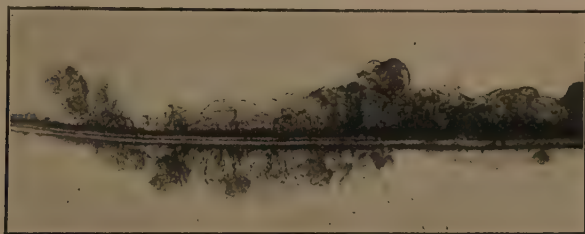


FIG. 1.—Trichomycosis flava.

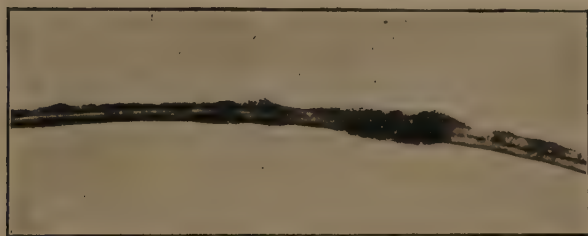


FIG. 2.—Trichomycosis nigra.

it grows and pushes its way under a cuticular scale and then works its way into the cortex, raising, in so doing, its superficial fibres, which, together with the cuticular scale, form a covering or protection for the fungus, which probably finds its nutriment in the cortex. The fungus does not penetrate very deep into the cortex, but grows outwards, forming the characteristic nodules. This method of growth explains why the hair is so little affected; the deeper layers of the cortex, the medulla, and the root of the hair are not involved, though the hair at times loses its lustre. In an early stage of the infection the cuticle and some fibres of the cortex may be seen to be raised in ridges, which

run in wavy lines across the shaft of the hair transversely to its long axis; masses of the fungus may be seen growing under these ridges. A nodule consists of a mass of the rod-like hyphæ of the *Nocardia* embedded in a firm homogeneous ground substance. In the black and red varieties the nocardial masses are surrounded by large numbers of cocci—*Micrococcus nigrescens* in the case of *Trichomycosis nigra* and *M. castellanii* in the case of *T. rubra*.

SYMPTOMATOLOGY.

Trichomycosis flava.—The affected hairs of the axilla and pubes present nodular formations of a yellow, and, occasionally, yellow-



FIG. 3.—Nodule of trichomycosis nigra, cleared specimen. Note bacilliform hyphæ of *Nocardia tenuis* and masses of cocci (*Micrococcus nigrescens*).

greyish colour, plainly visible to the naked eye, of rather soft consistency in the tropics, being easily removed by scraping with a triangular needle or any similar instrument (Coloured Plate: 3, and Fig. 1). The nodules are much harder and generally of much smaller size in temperate zones, so much so that at one time one of us considered that there were two distinct clinical varieties of trichomycosis flava—the tropical variety, characterised by the nodules being large, soft, and easily removed, and the European variety or lepothrix, *sensu stricto*, characterised by the nodules being hard, small and difficult to remove. The microscopical examination of cleared specimens shows the

formations to consist solely of enormous numbers of bacillary-like bodies—the rod-like hyphæ of *Nocardia tenuis*, Castellani, embedded into an amorphous cementing substance. Trichomycosis flava affects the hairs of the axillary regions, and more rarely those of the pubes. The affected hairs may occasionally become lustreless and somewhat depigmented.

Trichomycosis nigra.—The nodules are generally of the same size and consistency as those in trichomycosis flava, but are of a black colour (Coloured Plate: 4, and Fig. 2). The microscopical examination shows masses of rod-like nocardial elements (*Nocardia tenuis*), surrounded by large numbers of cocci (*M. nigrescens*) (Fig. 3). *Trichomycosis nigra* appears to affect only the axillary hairs, as we have never come across trichomycosis nigra of the pubic hairs.

Trichomycosis rubra.—The nodules are red (Coloured Plate: 5), but the red pigmentation is of varied intensity, and MacFie has described a subvariety of less vivid colour than usual which he has called *T. fusca*. The microscopical examination shows the nodules to consist of large masses of nocardial elements (*N. tenuis*), surrounded by masses of a coccus (*M. castellanii*). Trichomycosis rubra may affect both the axillary and the pubic hairs.

Mixed types.—It is not at all rare in the tropics to find patients affected with two varieties of trichomycosis: the hairs of the one armpit may show the yellow variety, while the hairs of the other armpit may present the black type or the red type. At times the same individual hair may present some of the nodules yellow and others black or red. We have not yet observed all the three varieties present at the same time on the same patient.

METHOD OF INFECTION.

The usual method of infection appears to be from man to man. This is strongly supported by the following observation made by Chalmers and O'Farrell in the Soudan:

“A young European, known to be quite uninfected with trichomycosis, became greatly interested in the work carried out on the condition at Khartoum. He examined cases which came to the laboratory, and handled and examined fresh hairs removed from the

axillæ. When he visited the laboratory he was clad in tennis attire, and as he moved about his shirt rucked up from below repeatedly, and whenever this occurred he adjusted it by pulling forward his leather belt with one hand while he pushed the soft shirt downwards inside his trousers with the other. Two weeks after examining cases he first noticed a reddish appearance on the hairs of the pubes. On examination it was found that the hairs were infected with the red variety of trichomycosis—that is to say, with the variety which he saw and handled in abundance. It grew rapidly on the pubic hairs, but did not extend to the axillæ.”

This observation tends to show that the incubation period is about two weeks, this being the length of time necessary before the infection produces sufficient growth on the hairs to attract attention.

COMPLICATIONS.

In acute cases in which the infection is very heavy an erythematous condition of the axillæ may be observed. Hyperidrosis is common, but so far we have not come across cases of chromidrosis associated with trichomycosis. In certain cases we have noticed a yellowish discoloration of the skin of the axilla and in one case which was more completely investigated a nocardial fungus was found in the patches very similar or identical with *N. tenuis*.

DIAGNOSIS.

This is very easy, being based on the presence of yellow nodules (trichomycosis flava), red nodules (trichomycosis rubra) and black nodules (trichomycosis nigra) on the hairs of the axillæ and pubes.

DIFFERENTIAL DIAGNOSIS.

The various types of trichomycosis have to be differentiated from Cheadle and Morris's tinea nodosa (known also as Beigel's trichosporosis), Behrend's nodular trichosporosis (Behrend's trichosporosis), Piedra (trichosporosis tropica), Unna's piedra nostras (Unna's trichosporosis), and finally Du Bois's trichosporosis. The differentiation is quite easy in the case of trichomycosis nigra and rubra, as none of the above conditions show any black or red pigmentation. These

conditions are also easily differentiated from trichomycosis flava, as they seldom, if ever, attack the axillary hair, and their causative fungi belong to the genus *Trichosporum*, Behrend, 1890. The hyphomycetes belonging to this genus are of much larger dimensions and show totally different morphological characters from *Nocardia tenuis*. The fungi of the genus *Trichosporum* are arthrospores living parasitically on the hairs in the form of large oval or roundish bodies varying in diameter from 3–4 μ to 12–15 μ . Fungi of the genus *Nocardia*, Toni and Trevisan, on the other hand, are bacilliform, and usually 1 μ or less in diameter (see Castellani and Chalmers' *Manual of Tropical Medicine*, 3rd edition, p. 1101).

Tinea nodosa, often known as Beigel's trichosporosis, was first described by Cheadle and Morris in London, and later by Beigel in Germany. It is a nodular affection of the hair of the scalp and is caused by *Trichosporum beigelii* (Rabenhorst, 1867).

Behrend's trichosporosis (Behrend's nodular trichomycosis) affects the hair of the beard and is due to *Trichosporum ovoides* (Behrend, 1890).

Unna's trichosporosis, or piedra nostras, is very similar to Behrend's trichosporosis; it attacks the hair of the moustache and beard, and is due to *Trichosporum ovale* (Unna, 1896).

Trichosporosis tropicalis (piedra) is common in certain parts of South America; it generally affects the hair of the scalp, and is characterised by the presence of extremely hard nodules, hence the name piedra (stone). It is caused by *Trichosporum giganteum* (Behrend, 1890).

Du Bois's trichosporosis has been observed on the pubic hair of persons suffering from diabetes and is caused by *Trichosporum glycophile* (Du Bois, 1910).

PROGNOSIS.

None of the varieties of trichomycosis axillaris has a tendency to spontaneous cure while the patients reside in a hot tropical country. On the patient going to a cold climate the condition may subside or even disappear completely. Trichomycosis nigra seems to disappear in a cold climate much more rapidly than *T. flava* or *T. rubra*.

Trichomycosis axillaris is an affection of not much importance, but we have known European ladies in the tropics greatly distressed by

it, as when they wear low-necked dresses the disfiguring red or black patches in the axillary regions are quite visible. It is a curious fact also that natives when affected with trichomycosis seem to regard it with disgust and readily seek treatment, and Chalmers and O'Farrell have brought forward the hypothesis that the general custom of shaving the axillary hair among certain native tribes may have originated in their profound dislike of this complaint.

TREATMENT.

The treatment originally used by one of us in Ceylon is generally efficacious. The affected hairs are dabbed twice daily with an alcoholic solution of formalin (formalin 3j, spir. rect. ad. ℥vi); at night a 2-5 per cent. sulphur ointment is rubbed in. To allay the irritation of the skin at times caused by this treatment, calamine lotion may be applied. Resorcin and salicylic alcoholic solutions have also been used, but as a rule they are not so efficacious. Tr. iodine alone has practically no effect, but is useful in obstinate cases after a few days of the formalin-sulphur treatment.

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